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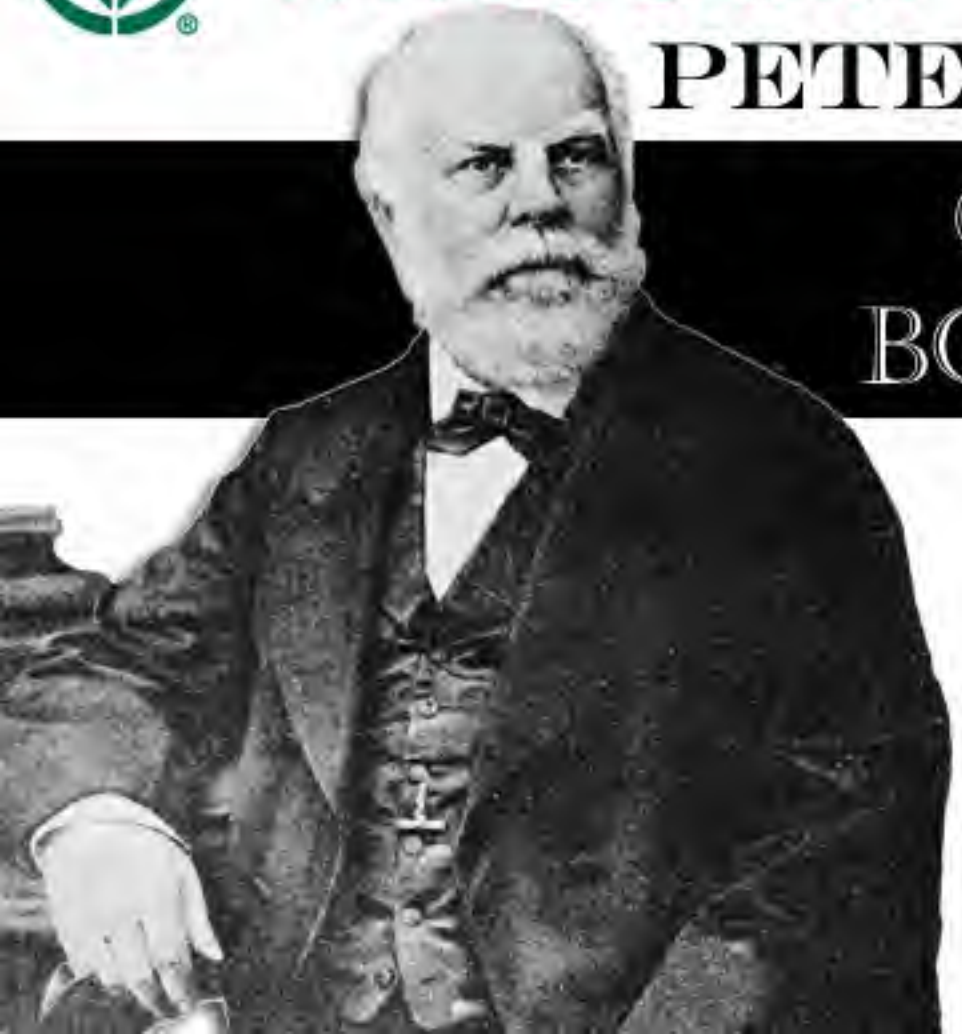

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THE AMERICAN JUNIPERS

OF THE SECTION SABINA.

By DR. GEORGE ENGELMANN.

From the *Transactions of the Academy of Science of St, Louis*, Vol III., No. 4.]

Read Nov., 1877.

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The American Junipers of the section Sabina.

By Dr. GEORGE ENGELMANN.

The species of our Junipers, are, on the whole, well enough recognized, but their scientific definition is very insufficient—the characters, given in the books, vague and indefinite.

I have had a good opportunity to study the different species and forms from all parts of our country, fresh and living as well as preserved in numerous collections; among them those contained in the great Herbaria of New York and Cambridge (Torrey and Gray) and those of Kew (Hooker), and especially those of Berlin, whence the types of the different Mexican species were sent to me by my late excellent friend, Alexander Braun.

With the exception of *Juniperus Sabina*, which with us is always a prostrate plant, all our species occur both in the form of low shrubs or of trees, a few of them of magnificent dimensions. In the arid mountain regions, the trunks of the different species which occur there frequently assume peculiar conical forms, very thick at base and rapidly tapering to a slender point.

The BARK is in most species thin, fibrous, and at last detached in shreds; only in *J. pachyphlœa* it is 1–3 inches thick, cracked like that of some oak or chestnut, the surface at last pealing off in thin layers.

The WOOD is fine-grained and compact but not always hard; its growth is very slow, so that trees of 200 years have a diameter of 4–6, or, in the species growing in more generous soil and a more favorable climate, of 12–18 inches. Therefore, when we hear of mountain forms (necessarily of slow growth) having near their base a diameter of 3 feet, we cannot help estimating their age* at a thousand years and upwards. In *J. occidentalis* the annual rings are often quite eccentric. The resin is confined to the cambium layer and the inner bark; the wood is quite free from it but extremely durable, and, at least in *J. Virginiana*, almost indestructible. In this species the heartwood is red (hence the name *Red Cedar*) and very aromatic, soft, and splitting easily;

* This is also alluded to in a letter received, after the above was in type, from Sir J. D. Hooker, who had just returned from an exploration of our western mountain regions, in which he speaks of the "stupendous age" of their Junipers, meaning probably *J. occidentalis*.

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in *J. Bermudiana* it is said to be similar but harder; in all the others, the wood of which I could examine, it is paler red or yellowish, harder and less fragrant; they split less readily, but are, in the regions where they abound, not rarely the most available and highly esteemed firewood.

The LEAVES of young plants or of vigorous shoots are, it is well known, acicular and arranged in alternating whorls of threes (rarely in twos), quite similar to the permanent leaves of the *Junipers* of the section of *Oxycedrus*, but the older and especially the fertile plants have very short, mostly closely imbricate, almost scale-like leaves, the lower part more or less adnate to and forming part of the branchlet itself. These leaves occur in some species in pairs, in others usually in threes, so as to form 4-sided or 6-sided branchlets, but this arrangement is not constant and ought not to be much relied on for specific characters. The leaves bear their stomata on the concave, upper, appressed side; the lower, convex side or back has no stomata, but is marked by a more or less distinct, either prominent or sunken "gland," as it is called: the dorsal and only resin-vesicle or duct of the leaf. This is globose or oblong according to the shape of the leaf, or rarely (in *J. Bermudiana*) elongated, and lies in some close to the epidermis, or is in others separated from it by a layer of parenchymatous cells. The contents of this resin-vesicle are in some species or in some localities excreted through the epidermis, and are apt to appear on the back of the leaves as an aromatic balsam, and, later, as condensed resin.

The edges of the leaf are rarely entire, mostly delicately denticulate, or irregularly fringed with minute, corneous, often curved processes. This character permits us to distinguish species where others may fail.

In the figure on the next page the form and proportions of the leaf-margin of the different species is represented as it appears when magnified 280 times; but a much lower power, even a good glass, in a favorable light, will enable the student to recognize its character. The figures show that only *J. Virginiana* and *Bermudiana* have entire leaves, while *J. Californica* has the most marked fringe; the other species are intermediate between these extremes.

Of the old world *Sabinæ*, which I have examined, only *J.*

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Chinensis (cultivated specimens) is in this respect similar to *J. Virginiana*; *J. fœtidissima* (coll. Hohenacker) has the strongest dentation, somewhat like Fig. 2, but with more erect teeth; *J. phœnicea* (from Italy) and *J. thurifera* (from Spain) are less marked, more like Fig. 3, and *J. excelsa* (coll. Kotschy) still less so, somewhat like Fig. 4, and only a little more than *J. Sabina* (from Switzerland), Fig. 7.

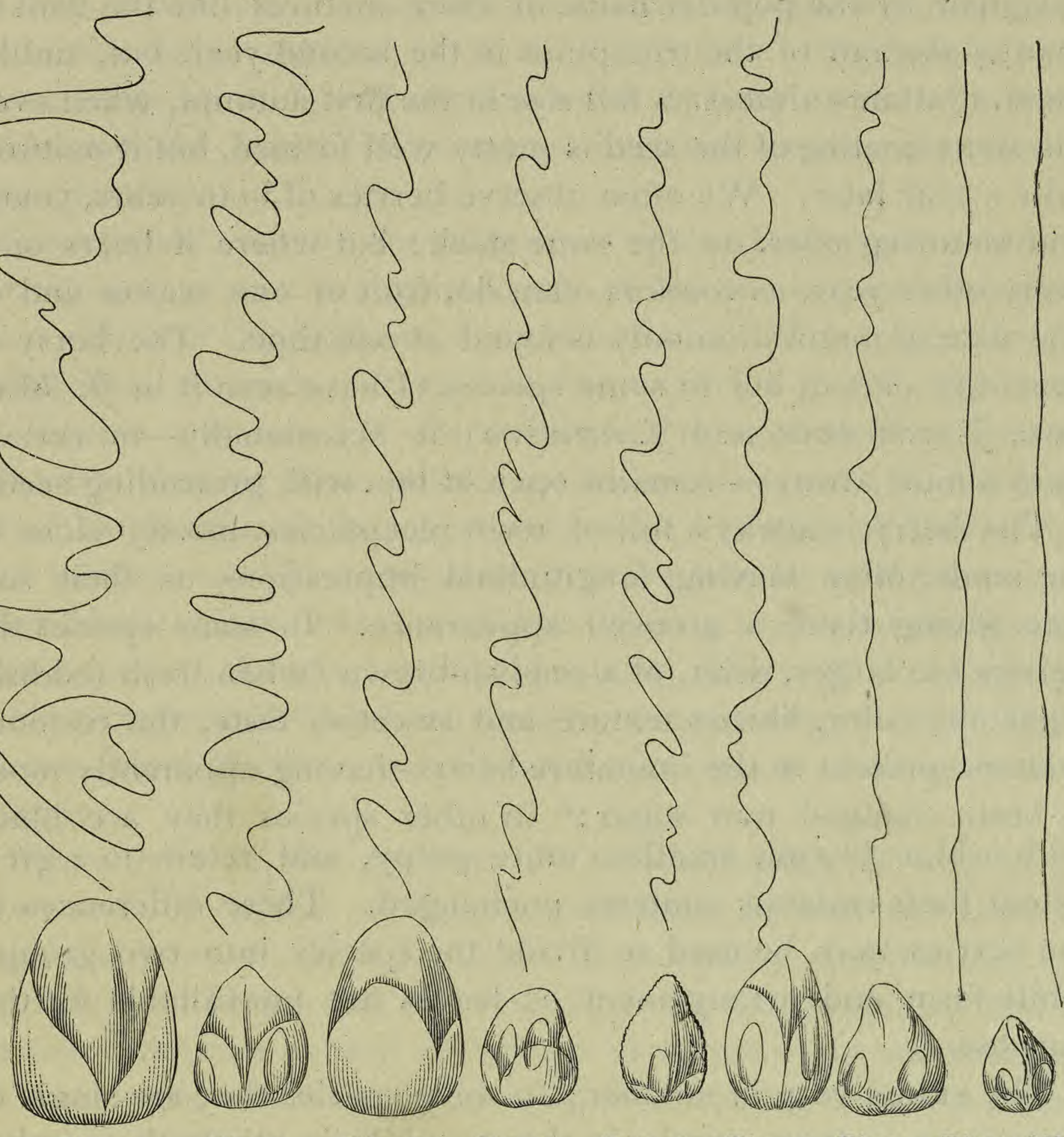

Fig. 1. *Fig.* 5. *Fig.* 2. *Fig.* 6. *Fig.* 5*. *Fig.* 3. *Fig.* 4. *Fig.* 7 & 8.

Margins of the leaves magnified 280 times, and seeds twice the natural size: Fig. 1, *J. Californica*; 2. *J. Mexicana*; 3. *J. pachyphlœa*; 4. *J. flaccida*; 5. *J. occidentalis*; 5*. var.? *conjungens*; 6. *J. tetragona*; 7. *J. Sabina*; 8. *J. Virginiana* and *Bermudiana*. On the seeds the impressions made by the resin vesicles and the pale bilobed hilum are distinctly visible. The seed under Fig. 7 & 8 is the same in both.

The species of *Sabina* are subdiœcious, or more commonly diœcious; no specific characters can be founded on these peculiarities.

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The male FLOWERS (*vulgo* aments) and female aments have, like the peduncles, and in continuation of them, binate or ternate scales; the edge of the anther-scales corresponds in its character to the margin of the leaves of the same species; the number of anther-cells varies from 4 to 8 on each scale, more in the robuster, less in the slenderer forms.

The juicy strobil, GALBULUS, which we may for shortness' sake designate by the popular name of *berry*, matures like the fruit of many oaks and of the true pines in the second year, but, unlike them, it attains almost its full size in the first autumn, when even the stony coating of the seed is pretty well formed, but it matures fully a year later. We often observe berries of both years, young and maturing ones, on the same stock; but where it bears only every other year, as conifers often do, fruit of one season and of one state of maturation only is found at one time. The berry is generally closed, but in some species (I have seen it in *J. Mexicana*, *J. occidentalis*, and *J. tetragona*) it occasionally—on certain trees almost always—remains open at top, with protruding seeds.

The berry is always full of resin receptacles, mostly close to the seeds, often leaving longitudinal impressions on their surface, giving them a grooved appearance. In some species the berries are larger, drier, of a reddish-brown (when fresh reddish-glaucous) color, fibrous texture and sweetish taste, the resinous matter—present in the immature berry—having apparently mostly been changed into sugar;* in other species they are black with a blue bloom, smaller, more pulpy, and retain to a great extent their resinous contents unchanged. These differences in the berries may be used to divide the species into two groups, while form and arrangement of leaves are unavailable for this purpose.

The SEEDS vary in number; in some species they are single or sometimes in twos, rarely in threes, while in others the number rises from 5 to 10 or even 12, of which some usually remain imperfect. The seeds have a hard, stony coating, often of great thickness, ovate in general outline, smooth, or grooved or angled and variously compressed, and sometimes rough or tubercled;

* I have been able to examine the fresh fruit of only *J. Californica* and *pachyphlæa*, but have little doubt that that of the other two species, referred here, is of the same character. A similar process seems to take place in the sap of the sugar-pine, *Pinus Lambertiana*.

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they are brown and shining upwards, and are marked below with a larger or smaller, mostly bilobed, pale hilum. I cannot discover that the shape of the seeds, the presence or absence of the grooves or impressions, or the roughness of the surface, have much specific value.

The embryo of most species has two cotyledons; only in *J. Californica* I find regularly more (4–6, mostly 5) cotyledons—a curious repetition of a constant character of *Abietineæ*, and perhaps the only instance of it in *Cupressineæ*. Marked as this peculiarity is, it is not accompanied by any other character which would justify us in separating this species generically from its allies.

The GEOGRAPHICAL DISTRIBUTION of our Junipers is an interesting and, at least in regard to one of the species, an abnormal one. Most of the Junipers are rather local. Three species (*J. Mexicana*, *flaccida*, *tetragona*) are confined to the highlands of Mexico and one (*J. Bermudiana*) to several West Indian Islands. Among those within our boundaries, one (*J. Californica*) is peculiar to the coast ranges and islands of California, and another one (*J. pachyphlœa*) to the interior of Arizona and New Mexico, into which and into Utah a variety of the former also extends. Another species, properly named *J. occidentalis*, is characteristic of the whole western mountain region from West Texas, New Mexico, and Colorado, as far as California and Oregon.

Then there is the northern *J. Sabina*, which as well as *J. communis*, of which we do not treat here, follows the laws of high northern, or, as it is called, circumpolar distribution, extending from Maine and Nova Scotia along the great lakes and to British Columbia as well as through Northern Asia and Europe, *J. communis* reaching down to lower latitudes than the other, especially in the mountain ranges.

Thus far all our species have not deviated in their distribution from the well known laws of geographical botany. But one species, our common Red Cedar (*J. Virginiana*), makes a remarkable exception. It is the only conifer and one of the very few trees* which is found east as well as west, and certainly the only

* The others belong to the universal poplars, and may perhaps as well be classed among the circumpolar vegetation extending south along the mountains.

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one which at the same time extends through so many degrees of latitude. It is well known from the St. Lawrence to the Cedar Keys of Florida, from the Atlantic to the Rocky Mountains; and farther, even to the Pacific coast of British Columbia.

I arrange the eight American species in the following order:

I. SABINÆ, with larger, reddish-glaucous, fibrous, dry, sweetish berries.

A. Seeds single or few; leaves fringed or denticulate.

a. Cotyledons 4–6.

1. *J. Californica.*

b. Cotyledons 2.

2. *J. Mexicana.*

B. Seeds numerous, 4–12; leaves slightly denticulate.

3. *J. pachyphlœa.*

4. *J. flaccida.*

II. SABINÆ, with smaller, bluish-black (rarely brown) pulpy berries, of resinous taste.

A. Leaves ciliate or denticulate.

5. *J. occidentalis.*

5*. *J. conjungens.*

6. *J. tetragona.*

B. Leaves entire or nearly so.

7. *J. Sabina.*

8. *J. Virginiana.*

9. *J. Bermudiana.*

1. J. CALIFORNICA, Carrière: A stout shrub, or small tree (rarely 20 to even 35 feet high) with stout branches, the branchlets perhaps the thickest of any *Sabina;* leaves almost always in 3's, in young shoots acerose, white above, in adult plants, even on the thicker branches, closely appressed, short and thick, rounded at tip, distinctly cartilaginous-fringed on the margins; anther-scales (18–24) mostly in 3's, rhomboid, scarcely acute; scales of female ament usually 6, spreading; berry globose or mostly oval, 5–6 lines long, with scale-tips scarcely prominent; seeds 1 or sometimes 2, 4–6 lines long, with a very thick and hard shell, smooth, shining brown above, with large bilobed whitish hilum. — Rev. Hort. 3, 352 (1854); Conif. 58. *J. tetragona*, var. *osteosperma*, Torr. Bot. Whipp. in Pac. R. Rep. 4, 141; Bot. Mex. Bound. 210. *J. Cerrosianus*, Kellogg, Proc. Calif. Acad. 2. 37, fide spec. auctoris in Herb. Torrey. (See Fig. 1.)

Var. UTAHENSIS: In all the parts smaller, leaves and tips of fruit-scales often in pairs, fringe of leaf-margin shorter; berries more commonly globose; seeds mostly single, smaller.

California, from San Francisco (Monte Diablo) southward, principally on the Coast range and on the Islands; the variety all over the southern parts of Utah and into Arizona and Nevada. — Bark shreddy, wood pale;

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about St. George, Utah, where the variety furnishes the common firewood, it is a small tree 20 feet high; berries smaller, 3–5 lines long; cotyledons same as in the species, never less than 4. Dr. Palmer has sent from the Colorado River a form with whitish, scaly bark, which I cannot otherwise distinguish, but have seen no mature fruit of it.—The plant is often confounded with the stouter forms of *J. occidentalis*, but in fruit can always be readily distinguished.

2. *J. Mexicana*, Schlechtend.: A bush or (fide Parlatore) a pyramidal tree; spray much more slender than the last, older branchlets with semi-acerose, squarrose leaves; leaves of ultimate branchlets mostly in pairs, slender, acute, irregularly denticulate; anther-scales in pairs (about 12) strongly cuspidate or almost acuminate; scales of female ament about 2 pairs, spreading, rarely in 3's; berry globose or oval, as large as and similar to that of the foregoing species; seeds single or often 2 or 3, similar to the last. — Linnæa 5, 77 (1830); ib. 12, 494. Parlat. in DeProd. 16, 2, 491. (See Fig. 2.)

Mexico.—The 1-seeded form is Shlechtendal's original, sent by *Schiede* from Llanos de Perote; Real del Monte, *Hartweg*, 433. A 2–3-seeded form has been collected at the last locality by *Ehrenberg* (often with protruding seeds) and *Gregg*, 636; in the Sierra Madre, *Seemann*, 2001; Cosiquiriachi, *Wislizenus*, 230.—Most collectors describe this species as a bush or small tree, but Parlatore assigns to it, without giving his authority, a height, sometimes, of 70–90 feet; he gives the bark as *secedens*, shreddy. The slender branchlets, the acute, denticulate, not deeply fringed leaves spreading on the older branchlets, and the regularly 2-cotyledonous embryo, distinguish it readily from the last.

3. J. PACHYPHLŒA, Torr.: A middle-sized tree with a spreading, rounded top, thick and much cracked bark and pale reddish wood, closely allied to the last, with the same squarrose leaves on the stouter branchlets, but distinguished by the slenderer, acuter, less prominently denticulate or ciliate leaves, usually in pairs, and by the obtusish anther-scales; berry globose or irregularly tubercled, 5–6 lines thick; seeds mostly 4, angular. —Bot. Whipp. in Pacif. R. Rep. 4, 142 (1857); Bot. Mex. Bound. 210; Parl. l. c. 490. *J. plochyderma*, Sitgr. Rep. (1853), tab. 16, spalm.; Parl. l. c. 492. (See Fig. 3.)

New Mexico and Arizona, *Woodhouse, Parry, Wright, Coues, Palmer, Greene.*—Further examination must show whether it stands not too close to the last; but the character of the bark seems to distinguish it completely from that and any other species. In the report of Sitgreave's Expedition, p. 12, this singular species is mentioned, and on page 173 Torrey gives a short account of this and two other forms, without naming them. The plate with the name of *J. plockyderma*, probably a mistake of the lithographer for *pachyderma*, gives a rough figure of our tree.

4. J. FLACCIDA, Schlectend.: A bush, or small or middle-sized tree with shreddy bark, with spreading branches and slender, nodding branchlets; leaves always in pairs, acute with spreading tips and slightly denticulate

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margins; male flowers quadrangular, narrow, consisting of 16–20 keeled cuspidate anther-scales; large (6–7 lines thick) globose or often irregularly tubercled berry, mostly with recurved acute scales, containing 8–12 seeds in several tiers; seeds small, much distorted, many of them abortive.—Linnæa 12, 495 (1838); Parlat. l. c. 492. (See Fig. 4.)

Mexico, *Ehrenberg* and others; *Coulter*, 1419; Saltillo, *Gregg*, 432, a shrub, 10 feet high.—Well distinguished by its slender branchlets and acute, mostly somewhat spreading leaves.

5. J. OCCIDENTALIS, Hook.: A shrub, or mostly a small tree (in Oregon of the largest dimensions) with shreddy bark and pale reddish-yellow wood; closely appressed leaves in 3's or often in pairs, obtuse or acutish. delicately fringed on the edges; anther-scales obtusish or short-cuspidate; berries 4–5 lines in diameter, with 1 or more seeds.—Hook. Fl. Bor. Am. 2, 166 (1840); Parl. l. c. 489. (See Fig. 5.)

Var. *a*. PLEIOSPERMA with straighter, stouter branchlets, leaves almost always in 3's; berries larger (4–5 lines diam.), very resinous, deep black-blue, with 2–3 much grooved seeds.—*J. excelsa*, Pursh. Fl. 2, 647, not M. Bieb. *J. Andina*, Nutt. Sylv. 3, 95, t. 110.

Oregon to the higher mountains of California, in the north sometimes a large tree (*Lewis*, *Douglass*, *Newberry*), generally smaller or bushy; if without fruit, it is not always easily distinguished from *J. Californica*, which Parlatore unites with it; the margin of the leaf is much like that of var. *Utahensis* of that species, but the fruit is very different.

Var. *β*. MONOSPERMA, a shrub or small tree, often with eccentric layers of wood (Cañon City, Colorado), of scraggy growth, with short branchlets at right angles; leaves as often in 2's as in 3's; berries smaller, with 2 or more, commonly only 1, less grooved seed.

From the Pike's Peak region of Colorado through West Texas and New Mexico to Arizona and California, where var. *a* takes its place.—In Colorado the berries are often copper colored, as Parlatore describes those of the species, and in some trees the seeds protrude.

Var.? *γ*. CONJUNGENS, a bush or tree 20–40 feet high, often with eccentric layers of wood; branchlets slender, with 4-ranked, obtuse, closely appressed, slightly denticulate leaves; anther-scales obtuse or slightly cuspidate; berries globose, 3–4 lines thick, with 1–2 smooth or more or less tuberculate seeds. (See Fig. 5*.)

West Texas, where it forms forests and is an important timber tree, "although not as large nor as easily worked and useful as the red cedar of the plains of Eastern Texas" (F. Lindheimer). *Berlandier*, 671, 2081; *Lindheimer*, *Wright*, *Bigelow*, *Hall.*—Mr. Chas. Wright found in the damp rocky woods of the mountains of Eastern Cuba a few individuals of a middle-sized tree, apparently very rare, of which only male specimens were obtained (Pl. Cub. 3187, *J. Virginiana*, Griseb. Pl. Cub. 217), which without fruit I cannot distinguish from this Texan form; what I take to be the same thing, has been sent from Mexico by Sartorius in Hb. Torrey, and by Aschenborn from Zimapan, 381, in the Berlin Herb.; the latter

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with small 1-seeded berries.—This form connects the northwestern *J. occidentalis* with the southern *J. tetragona*, so that it is sometimes difficult to clearly separate them.

6. J. TETRAGONA, Schlechtend.: A low bush with spreading branches and thick sharply quadrangular branchlets; leaves closely appressed, obtuse, strongly keeled, distinctly denticulate; anther-scales obtusish, short-cuspidate; berries globose, dark blue-black (4–5 lines thick), 3–5 seeded, seeds angular and more or less grooved or pitted.—Linnæa 12, 495 (1838); Parlat. l. c. 491. (See Fig. 6.)

Var. OLIGOSPERMA, a bush or low tree; berries smaller, with 1 or 2 more regularly formed seeds.

Mexico, Real del Monte, *Ehrenberg*, *Hartweg*, 436, *Uhde*; Orizaba, *Linden*.—A low shrub 3–6 feet high. The variety from Saltillo, *Gregg*, 106 & 398, 10–30 feet high, with seeds somewhat similar to var. ? *conjungens* of the last species, and occasionally protruding, but with stouter branchlets.

7. J. SABINA, Lin.; var. PROCUMBENS, Pursh.: A prostrate shrub with appressed or slightly squarrose acute leaves in pairs, margin slightly or indistinctly denticulate; anther-scales obtusish, nearly entire; berry on short recurved peduncles, 3–4 lines in diameter, with 1 or 2, rarely 3, often rough seeds.—Fl. 2, 647 (1816); *J. Sabina*, Michx. Fl. 2, 246; Parlat. l. c. 484; *J. prostrata*, Pers. syn. 2, 632; *J. repens*, Nutt. gen. 2, 245; *J. Sabina*, β *humilis*, Hook. Fl. Bor. Am. 2, 166. (See Fig. 7.)

From Maine and New Brunswick to the shores of the great Lakes and northward to the Hudson Bay regions; westward to the Yellowstone River and to British Columbia and the Pacific coast.—Michaux as well as Hooker seem to indicate that northward the ordinary form of *J. Sabina* is also found, but I have seen no specimens; the plants from the localities given above are all prostrate, spreading over and closely carpeting sandy shores and rocks, with stems up to 1 inch or more in thickness, with red heartwood and brown scaly, scarcely shreddy bark; the branches extend 6–10 feet or more; branchlets often covered with subacerose leaves, and sometimes even bearing fruit in that state; but generally the fertile plants have the short, appressed leaves common to the whole section. Mr. H. Gillman—late of Detroit, now in Waldo, Florida—who has very attentively studied the Flora of the Upper Lake country, found the branches usually flattened, and with eccentric annual rings. He observed that where they recline on rocky soil, the lower part, touching the rock, is rubbed off, or the formation of wood there prevented; but where they spread over fine sand, the lower side is protected and the upper surface undergoes a similar process through the friction of wind-driven sand. He occasionally found berries even 5 lines thick, containing as many as 4 seeds.

8. J. VIRGINIANA, Lin.: The largest, the widest spread and the most useful of our American Junipers, commonly of pyramidal form, with shreddy bark and red and aromatic heartwood; slender 4-angled branchlets, with opposite obtuse or mostly acutish leaves with entire margins;

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anther-scales 10–12, rounded, entire, each bearing usually 4 or sometimes 6 anther-cells; berries on straight peduncles, 1–2-seeded; seeds angled, mostly grooved, and often rough toward the upper end. — Spec. Pl. 1471 (1753); Parlat. l. c. 488. (See Fig. 8.)

From the St. Lawrence to Florida and from the Atlantic to the Northern Pacific; it is not found in Southern Texas, in the greater part of Utah and Arizona, and in the whole of California and perhaps Oregon; in Washington Territory and British Columbia it associates with *Sabina* and perhaps with *occidentalis*, and in the Rocky Mountains south of Pike's Peak with the latter species; on the upper Missouri (Cedar Island) it attains large dimensions. — Usually the berries are small, about 3 lines thick, but in the Rocky Mountains forms occur with berries of 4 or 5 lines in diameter, and with larger seeds; among the foot-hills of Pike's Peak the trees of this species have the size and shape of an apple tree, with a rounded, spreading top.

9. J. BERMUDIANA, Lin.; A tree said to have been common on the Bermudas, and also in other West Indian Islands, of which I have seen only a few specimens. Branchlets stout; leaves in pairs, oblong or linear-oblong, obtuse, closely appressed, with entire margins and a well marked linear gland or resin-duct on the back; anther-scales about 16, large, rounded, smooth-edged, with about 6 cells; berry with 2–4 seeds, much like those of the last species.—Spec. Pl. l. c.—Parlat. l. c. 490. (See Fig. 8.)

J. Barbadensis, Lin. is said to be the same species, and *Biota Meldensis*, Gord. its acerose young state. Michaux, as well as Parlatore, quotes Florida as its home, but all the specimens from that country which I have seen, even those from Cedar Keys, and those of Michaux's Herbarium in Paris under the name of *J. Barbadensis*, are nothing but forms of *J. Virginiana*, with very small, rounded and strongly convex leaves. The forms from the different West Indian Islands, all referred to *J. Bermudiana*, require further examination, as we know that one at least, from Cuba (see p. 590), is certainly quite different from it.

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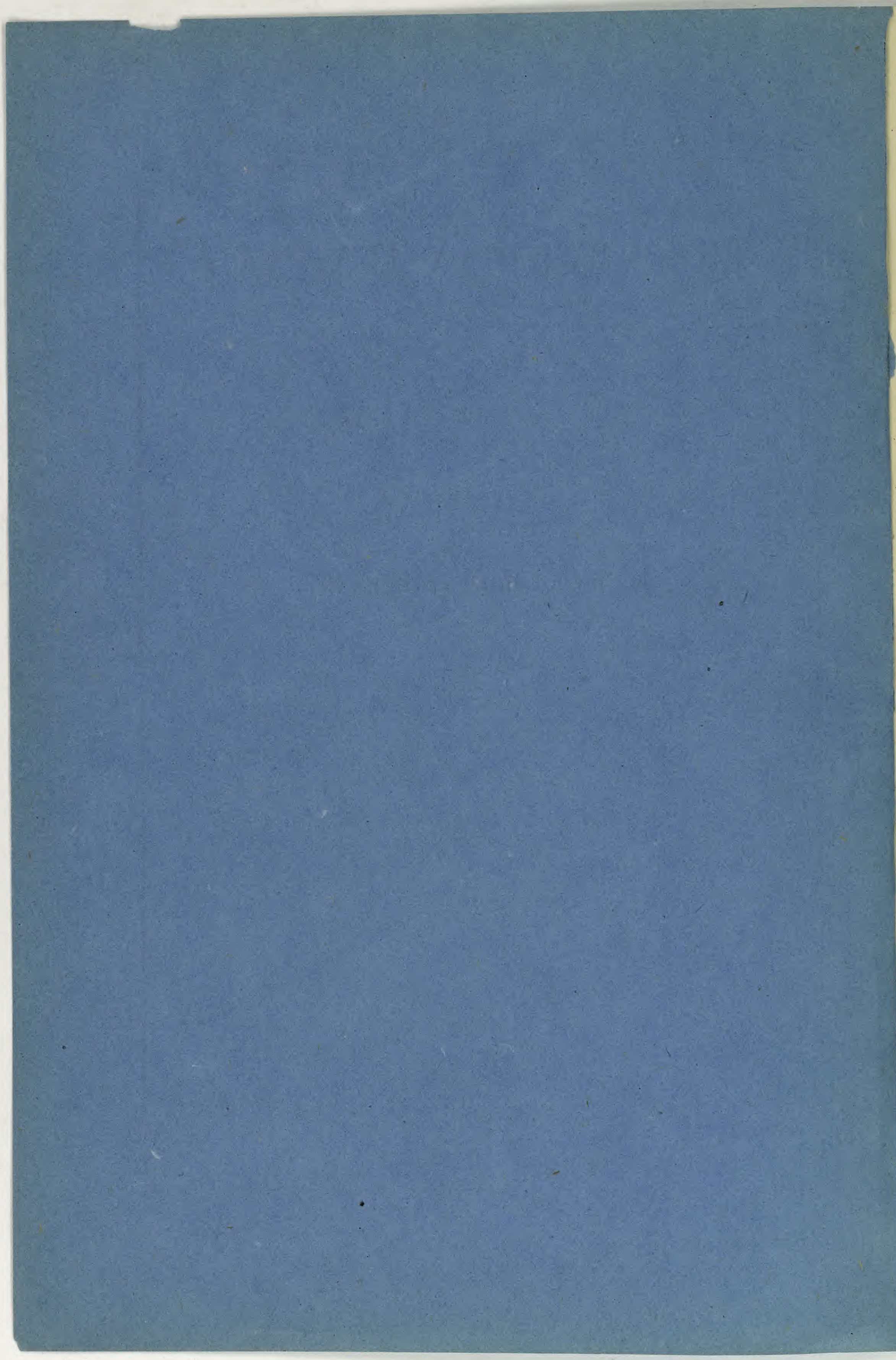

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With the exception of *Juniperus Sabina*, which with us is always a prostrate plant, all our species occur both in the form of low shrubs or of trees, a few of them of magnificent dimensions. In the arid mountain regions, the trunks of the different species which occur there frequently assume peculiar conical forms, very thick at base and rapidly tapering to a slender point.

The BARK is in most species thin, fibrous, and at last detached in shreds; only in *J. pachyphlœa* it is 1–3 inches thick, cracked like that of some oak or chestnut, the surface at last pealing off in thin layers.

The WOOD is fine-grained and compact but not always hard; its growth is very slow, so that trees of 200 years have a diameter of 4–6, or, in the species growing in more generous soil and a more favorable climate, of 12–18 inches. Therefore, when we hear of mountain forms (necessarily of slow growth) having near their base a diameter of 3 feet, we cannot help estimating their age* at a thousand years and upwards. In *J. occidentalis* the annual rings are often quite eccentric. The resin is confined to the cambium layer and the inner bark; the wood is quite free from it but extremely durable, and, at least in *J. Virginiana*, almost indestructible. In this species the heartwood is red (hence the name *Red Cedar*) and very aromatic, soft, and splitting easily;

* This is also alluded to in a letter received, after the above was in type, from Sir J. D. Hooker, who had just returned from an exploration of our western mountain regions, in which he speaks of the "stupendous age" of their Junipers, meaning probably *J. occidentalis*.

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in *J. Bermudiana* it is said to be similar but harder; in all the others, the wood of which I could examine, it is paler red or yellowish, harder and less fragrant; they split less readily, but are, in the regions where they abound, not rarely the most available and highly esteemed firewood.

The LEAVES of young plants or of vigorous shoots are, it is well known, acicular and arranged in alternating whorls of threes (rarely in twos), quite similar to the permanent leaves of the *Junipers* of the section of *Oxycedrus*, but the older and especially the fertile plants have very short, mostly closely imbricate, almost scale-like leaves, the lower part more or less adnate to and forming part of the branchlet itself. These leaves occur in some species in pairs, in others usually in threes, so as to form 4-sided or 6-sided branchlets, but this arrangement is not constant and ought not to be much relied on for specific characters. The leaves bear their stomata on the concave, upper, appressed side; the lower, convex side or back has no stomata, but is marked by a more or less distinct, either prominent or sunken "gland," as it is called: the dorsal and only resin-vesicle or duct of the leaf. This is globose or oblong according to the shape of the leaf, or rarely (in *J. Bermudiana*) elongated, and lies in some close to the epidermis, or is in others separated from it by a layer of parenchymatous cells. The contents of this resin-vesicle are in some species or in some localities excreted through the epidermis, and are apt to appear on the back of the leaves as an aromatic balsam, and, later, as condensed resin.

The edges of the leaf are rarely entire, mostly delicately denticulate, or irregularly fringed with minute, corneous, often curved processes. This character permits us to distinguish species where others may fail.

In the figure on the next page the form and proportions of the leaf-margin of the different species is represented as it appears when magnified 280 times; but a much lower power, even a good glass, in a favorable light, will enable the student to recognize its character. The figures show that only *J. Virginiana* and *Bermudiana* have entire leaves, while *J. Californica* has the most marked fringe; the other species are intermediate between these extremes.

Of the old world *Sabinæ*, which I have examined, only *J.*

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Chinensis (cultivated specimens) is in this respect similar to *J. Virginiana*; *J. fœtidissima* (coll. Hohenacker) has the strongest dentation, somewhat like Fig. 2, but with more erect teeth; *J. phœnicea* (from Italy) and *J. thurifera* (from Spain) are less marked, more like Fig. 3, and *J. excelsa* (coll. Kotschy) still less so, somewhat like Fig. 4, and only a little more than *J. Sabina* (from Switzerland), Fig. 7.

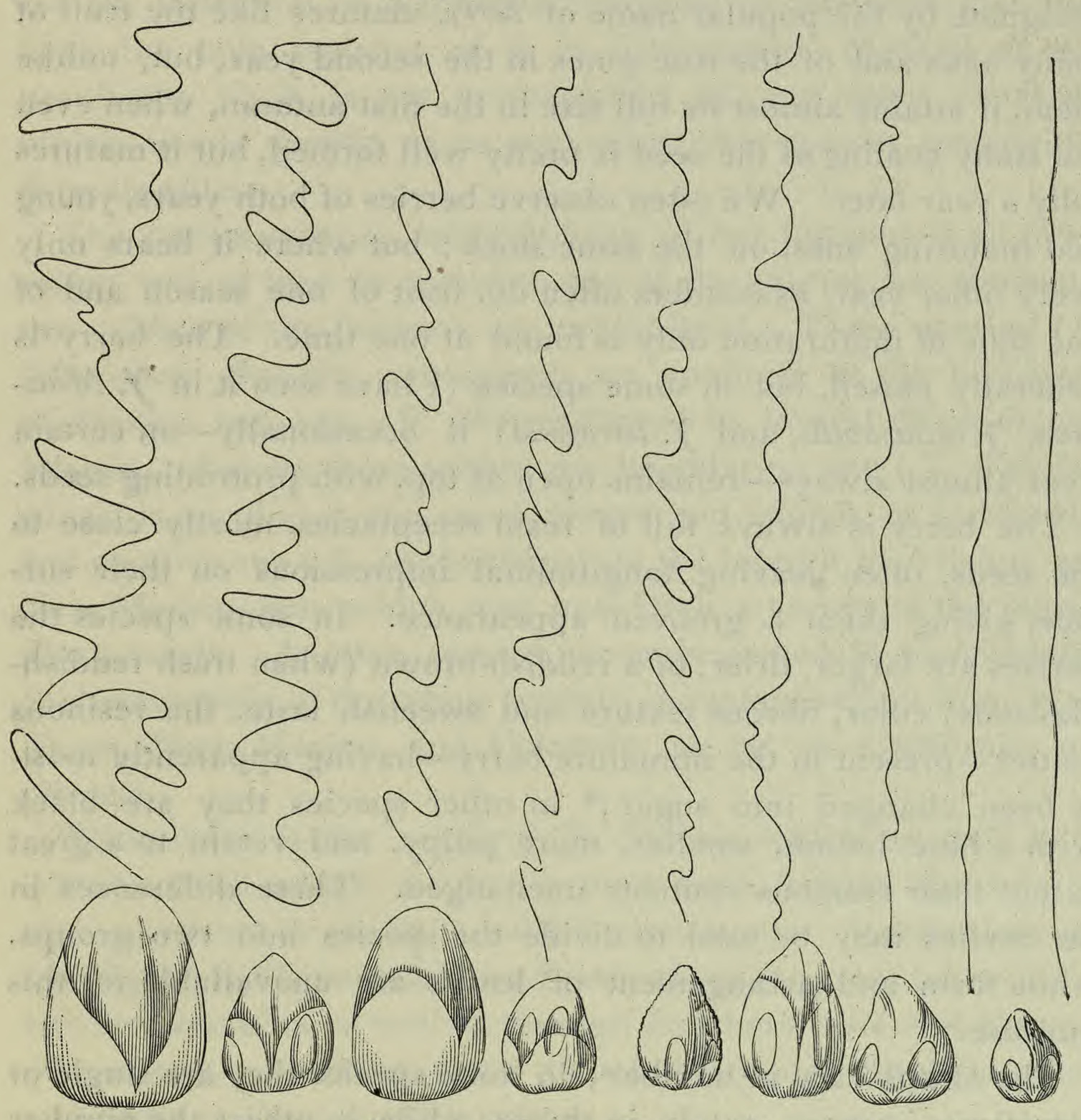

Fig. 1. *Fig.* 5. *Fig.* 2. *Fig.* 6. *Fig.* 5*. *Fig.* 3. *Fig.* 4. *Fig.* 7 & 8.

Margins of the leaves magnified 280 times, and seeds twice the natural size: Fig. 1, *J. Californica*; 2. *J. Mexicana*; 3. *J. pachyphlœa*; 4. *J. flaccida*; 5. *J. occidentalis*; 5*. var.? *conjungens*; 6. *J. tetragona*; 7. *J. Sabina*; 8. *J. Virginiana* and *Bermudiana*. On the seeds the impressions made by the resin vesicles and the pale bilobed hilum are distinctly visible. The seed under Fig. 7 & 8 is the same in both.

The species of *Sabina* are subdiœcious, or more commonly diœcious; no specific characters can be founded on these peculiarities.

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The male FLOWERS (*vulgo* aments) and female aments have, like the peduncles, and in continuation of them, binate or ternate scales; the edge of the anther-scales corresponds in its character to the margin of the leaves of the same species; the number of anther-cells varies from 4 to 8 on each scale, more in the robuster, less in the slenderer forms.

The juicy strobil, GALBULUS, which we may for shortness' sake designate by the popular name of *berry*, matures like the fruit of many oaks and of the true pines in the second year, but, unlike them, it attains almost its full size in the first autumn, when even the stony coating of the seed is pretty well formed, but it matures fully a year later. We often observe berries of both years, young and maturing ones, on the same stock; but where it bears only every other year, as conifers often do, fruit of one season and of one state of maturation only is found at one time. The berry is generally closed, but in some species (I have seen it in *J. Mexicana*, *J. occidentalis*, and *J. tetragona*) it occasionally—on certain trees almost always—remains open at top, with protruding seeds.

The berry is always full of resin receptacles, mostly close to the seeds, often leaving longitudinal impressions on their surface, giving them a grooved appearance. In some species the berries are larger, drier, of a reddish-brown (when fresh reddish-glaucous) color, fibrous texture and sweetish taste, the resinous matter—present in the immature berry—having apparently mostly been changed into sugar;* in other species they are black with a blue bloom, smaller, more pulpy, and retain to a great extent their resinous contents unchanged. These differences in the berries may be used to divide the species into two groups, while form and arrangement of leaves are unavailable for this purpose.

The SEEDS vary in number; in some species they are single or sometimes in twos, rarely in threes, while in others the number rises from 5 to 10 or even 12, of which some usually remain imperfect. The seeds have a hard, stony coating, often of great thickness, ovate in general outline, smooth, or grooved or angled and variously compressed, and sometimes rough or tubercled;

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* I have been able to examine the fresh fruit of only *J. Californica* and *pachyphlœa*, but have little doubt that that of the other two species, referred here, is of the same character. A similar process seems to take place in the sap of the sugar-pine, *Pinus Lambertiana*.

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they are brown and shining upwards, and are marked below with a larger or smaller, mostly bilobed, pale hilum. I cannot discover that the shape of the seeds, the presence or absence of the grooves or impressions, or the roughness of the surface, have much specific value.

The embryo of most species has two cotyledons; only in *J. Californica* I find regularly more (4–6, mostly 5) cotyledons—a curious repetition of a constant character of *Abietineæ*, and perhaps the only instance of it in *Cupressineæ*. Marked as this peculiarity is, it is not accompanied by any other character which would justify us in separating this species generically from its allies.

The GEOGRAPHICAL DISTRIBUTION of our Junipers is an interesting and, at least in regard to one of the species, an abnormal one. Most of the Junipers are rather local. Three species (*J. Mexicana*, *flaccida*, *tetragona*) are confined to the highlands of Mexico and one (*J. Bermudiana*) to several West Indian Islands. Among those within our boundaries, one (*J. Californica*) is peculiar to the coast ranges and islands of California, and another one (*J. pachyphlœa*) to the interior of Arizona and New Mexico, into which and into Utah a variety of the former also extends. Another species, properly named *J. occidentalis*, is characteristic of the whole western mountain region from West Texas, New Mexico, and Colorado, as far as California and Oregon.

Then there is the northern *J. Sabina*, which as well as *J. communis*, of which we do not treat here, follows the laws of high northern, or, as it is called, circumpolar distribution, extending from Maine and Nova Scotia along the great lakes and to British Columbia as well as through Northern Asia and Europe, *J. communis* reaching down to lower latitudes than the other, especially in the mountain ranges.

Thus far all our species have not deviated in their distribution from the well known laws of geographical botany. But one species, our common Red Cedar (*J. Virginiana*), makes a remarkable exception. It is the only conifer and one of the very few trees* which is found east as well as west, and certainly the only

* The others belong to the universal poplars, and may perhaps as well be classed among the circumpolar vegetation extending south along the mountains.

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one which at the same time extends through so many degrees of latitude. It is well known from the St. Lawrence to the Cedar Keys of Florida, from the Atlantic to the Rocky Mountains; and farther, even to the Pacific coast of British Columbia.

I arrange the eight American species in the following order:

I. SABINÆ, with larger, reddish-glaucous, fibrous, dry, sweetish berries.

A. Seeds single or few; leaves fringed or denticulate.

a. Cotyledons 4–6.

1. *J. Californica.*

b. Cotyledons 2.

2. *J. Mexicana.*

B. Seeds numerous, 4–12; leaves slightly denticulate.

3. *J. pachyphlæa.*

4. *J. flaccida.*

II. SABINÆ, with smaller, bluish-black (rarely brown) pulpy berries, of resinous taste.

A. Leaves ciliate or denticulate.

5. *J. occidentalis.*

5*. *J. conjungens.*

6. *J. tetragona.*

B. Leaves entire or nearly so.

7. *J. Sabina.*

8. *J. Virginiana.*

9. *J. Bermudiana.*

1. J. CALIFORNICA, Carrière: A stout shrub, or small tree (rarely 20 to even 35 feet high) with stout branches, the branchlets perhaps the thickest of any *Sabina;* leaves almost always in 3's, in young shoots acerose, white above, in adult plants, even on the thicker branches, closely appressed, short and thick, rounded at tip, distinctly cartilaginous-fringed on the margins; anther-scales (18–24) mostly in 3's, rhomboid, scarcely acute; scales of female ament usually 6, spreading; berry globose or mostly oval, 5–6 lines long, with scale-tips scarcely prominent; seeds 1 or sometimes 2, 4–6 lines long, with a very thick and hard shell, smooth, shining brown above, with large bilobed whitish hilum. — Rev. Hort. 3, 352 (1854); Conif. 58. *J. tetragona*, var. *osteosperma*, Torr. Bot. Whipp. in Pac. R. Rep. 4, 141; Bot. Mex. Bound. 210. *J. Cerrosianus*, Kellogg, Proc. Calif. Acad. 2. 37, fide spec. auctoris in Herb. Torrey. (See Fig. 1.)

Var. UTAHENSIS: In all the parts smaller, leaves and tips of fruit-scales often in pairs, fringe of leaf-margin shorter; berries more commonly globose; seeds mostly single, smaller.

California, from San Francisco (Monte Diablo) southward, principally on the Coast range and on the Islands; the variety all over the southern parts of Utah and into Arizona and Nevada. — Bark shreddy, wood pale;

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about St. George, Utah, where the variety furnishes the common firewood, it is a small tree 20 feet high; berries smaller, 3–5 lines long; cotyledons same as in the species, never less than 4. Dr. Palmer has sent from the Colorado River a form with whitish, scaly bark, which I cannot otherwise distinguish, but have seen no mature fruit of it.—The plant is often confounded with the stouter forms of *J. occidentalis*, but in fruit can always be readily distinguished.

2. *J. Mexicana*, Schlechtend.: A bush or (fide Parlatore) a pyramidal tree; spray much more slender than the last, older branchlets with semi-acerose, squarrose leaves; leaves of ultimate branchlets mostly in pairs, slender, acute, irregularly denticulate; anther-scales in pairs (about 12) strongly cuspidate or almost acuminate; scales of female ament about 2 pairs, spreading, rarely in 3's; berry globose or oval, as large as and similar to that of the foregoing species; seeds single or often 2 or 3, similar to the last. — Linnæa 5, 77 (1830); ib. 12, 494. Parlat. in DeProd. 16, 2, 491. (See Fig. 2.)

Mexico.—The 1-seeded form is Shlechtendal's original, sent by *Schiede* from Llanos de Perote; Real del Monte, *Hartweg*, 433. A 2–3-seeded form has been collected at the last locality by *Ehrenberg* (often with protruding seeds) and *Gregg*, 636; in the Sierra Madre, *Seemann*, 2001; Cosiquiriachi, *Wislizenus*, 230.—Most collectors describe this species as a bush or small tree, but Parlatore assigns to it, without giving his authority, a height, sometimes, of 70–90 feet; he gives the bark as *secedens*, shreddy. The slender branchlets, the acute, denticulate, not deeply fringed leaves spreading on the older branchlets, and the regularly 2-cotyledonous embryo, distinguish it readily from the last.

3. J. PACHYPHLŒA, Torr.: A middle-sized tree with a spreading, rounded top, thick and much cracked bark and pale reddish wood, closely allied to the last, with the same squarrose leaves on the stouter branchlets, but distinguished by the slenderer, acuter, less prominently denticulate or ciliate leaves, usually in pairs, and by the obtusish anther-scales; berry globose or irregularly tubercled, 5–6 lines thick; seeds mostly 4, angular. —Bot. Whipp. in Pacif. R. Rep. 4, 142 (1857); Bot. Mex. Bound. 210; Parl. l. c. 490. *J. plochyderma*, Sitgr. Rep. (1853), tab. 16, spalm.; Parl. l. c. 492. (See Fig. 3.)

New Mexico and Arizona, *Woodhouse*, *Parry*, *Wright*, *Coues*, *Palmer*, *Greene*.—Further examination must show whether it stands not too close to the last; but the character of the bark seems to distinguish it completely from that and any other species. In the report of Sitgreave's Expedition, p. 12, this singular species is mentioned, and on page 173 Torrey gives a short account of this and two other forms, without naming them. The plate with the name of *J. plochyderma*, probably a mistake of the lithographer for *pachyderma*, gives a rough figure of our tree.

4. J. FLACCIDA, Schlectend.: A bush, or small or middle-sized tree with shreddy bark, with spreading branches and slender, nodding branchlets; leaves always in pairs, acute with spreading tips and slightly denticulate

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margins; male flowers quadrangular, narrow, consisting of 16–20 keeled cuspidate anther-scales; large (6–7 lines thick) globose or often irregularly tubercled berry, mostly with recurved acute scales, containing 8–12 seeds in several tiers; seeds small, much distorted, many of them abortive.—Linnæa 12, 495 (1838); Parlat. l. c. 492. (See Fig. 4.)

Mexico, *Ehrenberg* and others; *Coulter*, 1419; Saltillo, *Gregg*, 432, a shrub, 10 feet high.—Well distinguished by its slender branchlets and acute, mostly somewhat spreading leaves.

5. J. OCCIDENTALIS, Hook.: A shrub, or mostly a small tree (in Oregon of the largest dimensions) with shreddy bark and pale reddish-yellow wood; closely appressed leaves in 3's or often in pairs, obtuse or acutish. delicately fringed on the edges; anther-scales obtusish or short-cuspidate; berries 4–5 lines in diameter, with 1 or more seeds.—Hook. Fl. Bor. Am. 2, 166 (1840); Parl. l. c. 489. (See Fig. 5.)

Var. *a*. PLEIOSPERMA with straighter, stouter branchlets, leaves almost always in 3's; berries larger (4–5 lines diam.), very resinous, deep black-blue, with 2–3 much grooved seeds.—*J. excelsa*, Pursh. Fl. 2, 647, not M. Bieb. *J. Andina*, Nutt. Sylv. 3, 95, t. 110.

Oregon to the higher mountains of California, in the north sometimes a large tree (*Lewis*, *Douglass*, *Newberry*), generally smaller or bushy; if without fruit, it is not always easily distinguished from *J. Californica*, which Parlatore unites with it; the margin of the leaf is much like that of var. *Utahensis* of that species, but the fruit is very different.

Var. *β*. MONOSPERMA, a shrub or small tree, often with eccentric layers of wood (Cañon City, Colorado), of scraggy growth, with short branchlets at right angles; leaves as often in 2's as in 3's; berries smaller, with 2 or more, commonly only 1, less grooved seed.

From the Pike's Peak region of Colorado through West Texas and New Mexico to Arizona and California, where var. *a* takes its place.—In Colorado the berries are often copper colored, as Parlatore describes those of the species, and in some trees the seeds protrude.

Var.? *γ*. CONJUNGENS, a bush or tree 20–40 feet high, often with eccentric layers of wood; branchlets slender, with 4-ranked, obtuse, closely appressed, slightly denticulate leaves; anther-scales obtuse or slightly cuspidate; berries globose, 3–4 lines thick, with 1–2 smooth or more or less tuberculate seeds. (See Fig. 5*.)

West Texas, where it forms forests and is an important timber tree, "although not as large nor as easily worked and useful as the red cedar of the plains of Eastern Texas" (F. Lindheimer). *Berlandier*, 671, 2081; *Lindheimer*, *Wright*, *Bigelow*, *Hall.*—Mr. Chas. Wright found in the damp rocky woods of the mountains of Eastern Cuba a few individuals of a middle-sized tree, apparently very rare, of which only male specimens were obtained (Pl. Cub. 3187, *J. Virginiana*, Griseb. Pl. Cub. 217), which without fruit I cannot distinguish from this Texan form; what I take to be the same thing, has been sent from Mexico by Sartorius in Hb. Torrey, and by Aschenborn from Zimapan, 381, in the Berlin Herb.; the latter

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with small 1-seeded berries.—This form connects the northwestern *J. occidentalis* with the southern *J. tetragona*, so that it is sometimes difficult to clearly separate them.

6. J. TETRAGONA, Schlechtend.: A low bush with spreading branches and thick sharply quadrangular branchlets; leaves closely appressed, obtuse, strongly keeled, distinctly denticulate; anther-scales obtusish, short-cuspidate; berries globose, dark blue-black (4--5 lines thick), 3–5 seeded, seeds angular and more or less grooved or pitted.—Linnæa 12, 495 (1838); Parlat. l. c. 491. (See Fig. 6.)

Var. OLIGOSPERMA, a bush or low tree; berries smaller, with 1 or 2 more regularly formed seeds.

Mexico, Real del Monte, *Ehrenberg*, *Hartweg*, 436, *Uhde*; Orizaba, *Linden*.—A low shrub 3–6 feet high. The variety from Saltillo, *Gregg*, 106 & 398, 10–30 feet high, with seeds somewhat similar to var. ? *conjungens* of the last species, and occasionally protruding, but with stouter branchlets.

7. J. SABINA, Lin.; var. PROCUMBENS, Pursh.: A prostrate shrub with appressed or slightly squarrose acute leaves in pairs, margin slightly or indistinctly denticulate; anther-scales obtusish, nearly entire; berry on short recurved peduncles, 3–4 lines in diameter, with 1 or 2, rarely 3, often rough seeds.—Fl. 2, 647 (1816); *J. Sabina*, Michx. Fl. 2, 246; Parlat. l. c. 484; *J. prostrata*, Pers. syn. 2, 632; *J. repens*, Nutt. gen. 2, 245; *J. Sabina*, *β humilis*, Hook. Fl. Bor. Am. 2, 166. (See Fig. 7.)

From Maine and New Brunswick to the shores of the great Lakes and northward to the Hudson Bay regions; westward to the Yellowstone River and to British Columbia and the Pacific coast.—Michaux as well as Hooker seem to indicate that northward the ordinary form of *J. Sabina* is also found, but I have seen no specimens; the plants from the localities given above are all prostrate, spreading over and closely carpeting sandy shores and rocks, with stems up to 1 inch or more in thickness, with red heartwood and brown scaly, scarcely shreddy bark; the branches extend 6–10 feet or more; branchlets often covered with subacerose leaves, and sometimes even bearing fruit in that state; but generally the fertile plants have the short, appressed leaves common to the whole section. Mr. H. Gillman—late of Detroit, now in Waldo, Florida—who has very attentively studied the Flora of the Upper Lake country, found the branches usually flattened, and with eccentric annual rings. He observed that where they recline on rocky soil, the lower part, touching the rock, is rubbed off, or the formation of wood there prevented; but where they spread over fine sand, the lower side is protected and the upper surface undergoes a similar process through the friction of wind-driven sand. He occasionally found berries even 5 lines thick, containing as many as 4 seeds.

8. J. VIRGINIANA, Lin.: The largest, the widest spread and the most useful of our American Junipers, commonly of pyramidal form, with shreddy bark and red and aromatic heartwood; slender 4-angled branchlets, with opposite obtuse or mostly acutish leaves with entire margins;

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anther-scales 10–12, rounded, entire, each bearing usually 4 or sometimes 6 anther-cells; berries on straight peduncles, 1–2-seeded; seeds angled, mostly grooved, and often rough toward the upper end. — Spec. Pl. 1471 (1753); Parlat. l. c. 488. (See Fig. 8.)

From the St. Lawrence to Florida and from the Atlantic to the Northern Pacific; it is not found in Southern Texas, in the greater part of Utah and Arizona, and in the whole of California and perhaps Oregon; in Washington Territory and British Columbia it associates with *Sabina* and perhaps with *occidentalis*, and in the Rocky Mountains south of Pike's Peak with the latter species; on the upper Missouri (Cedar Island) it attains large dimensions. — Usually the berries are small, about 3 lines thick, but in the Rocky Mountains forms occur with berries of 4 or 5 lines in diameter, and with larger seeds; among the foot-hills of Pike's Peak the trees of this species have the size and shape of an apple tree, with a rounded, spreading top.

9. J. BERMUDIANA, Lin.; A tree said to have been common on the Bermudas, and also in other West Indian Islands, of which I have seen only a few specimens. Branchlets stout; leaves in pairs, oblong or linear-oblong, obtuse, closely appressed, with entire margins and a well marked linear gland or resin-duct on the back; anther-scales about 16, large, rounded, smooth-edged, with about 6 cells; berry with 2–4 seeds, much like those of the last species.—Spec. Pl. l. c.—Parlat. l. c. 490. (See Fig. 8.)

J. Barbadensis, Lin. is said to be the same species, and *Biota Meldensis*, Gord. its acerose young state. Michaux, as well as Parlatore, quotes Florida as its home, but all the specimens from that country which I have seen, even those from Cedar Keys, and those of Michaux's Herbarium in Paris under the name of *J. Barbadensis*, are nothing but forms of *J. Virginiana*, with very small, rounded and strongly convex leaves. The forms from the different West Indian Islands, all referred to *J. Bermudiana*, require further examination, as we know that one at least, from Cuba (see p. 590), is certainly quite different from it.

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